Effectiveness on Soil and Foliar Applied Micronutrient Mixes

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Abstract

Use of micronutrient mixes is often promoted as a means of alleviating micronutrient deficiencies or simply providing a "balanced" nutrition to crops. We carried out ninteen experiment with wheat, twenty-nine with barley and five with canola from 1989 to 1994 to ascertain whether "targeted" or "non-targeted" use of micronutrient mixes provide an effective means of alleviating micronutrient deficiencies or simply increase yield due to a "balanced" nutrition. Two commercially available products were used, one for soil and one for foliar applications. The product for soil application was banded, broadcast and incorporated or seed-placed in five experiments with wheat and barley. There were no statistically ($P<0.05$) yield increases with any of the uses of this product. Foliar applications of the other product, on the other hand, resulted in a number of significant increases, namely, in four of nineteen experiments with wheat, in eight of twenty-seven experiments with barley and in two of five experiments with canola. None of these responses could provide an economic return or be predicted based on either soil tests or targeted yields.

Introduction

Micronutrient deficiencies in prairie soils are known to occur on transitional soils with low organic matter and alkaline pH (Karamanos 1997a,b; Karamanos et al. 1985b, 1986; Kruger et al. 1984; McGregor 1972; Penney et al. 1988; Singh et al. 1987) and organic (peat) soils (Karamanos et al. 1985a, 1991; Reid 1982). Identification of micronutrient deficiencies and management practices to alleviate these deficiencies are discussed elsewhere in these Proceedings (Karamanos, 2000). A number of either soil or foliar applied multi-micronutrient products that are extensively used in other parts of the world have penetrated the western Canadian market based on the premise that their use aids a holistic approach to growing crops. Further claims address an optimum "balance" of all nutrients and especially micronutrients in achieving maximum yields. Indeed an optimum balance of applied nutrients may be of extreme importance in many parts of the world but very little information does exist for western Canadian conditions. Therefore, a series of experiments were carried out to ascertain whether "targeted" or "non-targeted" use of micronutrient mixes:

1. Provides an effective means of alleviating micronutrient deficiencies;
2. Provides a "balanced" nutrition, therefore, leads to yield increases.

Materials and Methods

Two products were selected for the study because of their availability in western Canada (Table 1).

Table 1. Micronutrient content and method of application of the mixes used in the study.

Mix	Constituents		Method of application	Stage of application	Rate of application
1	Cu 0.15%	B 0.08%	Foliar	Cereals: Tillering and Boot stage Canola: Spiking and early flowering	5 to 8 lb/acre each application
	Fe 0.10%	Mo 0.0005%			
	Mn 0.10%	Zn 1.00%			
2	Zn 18%	Fe 4%	Soil	Spring seed-row	12 lb/acre
	Mn 8%	B 2%			
	Cu 4%	S 8%			

All experiments were carried out between 1989 and 1994 at various locations in Alberta representing the majority of agroecological environments found in western Canada. In total, forty-seven experiments involving micronutrient mixes were carried out. Experimental designs were organized in three main categories (Tables 2 to 4) based on the primary nutrient investigated in each of the experiment. In all case, micronutrient applications were incorporated as a sub-treatment of the main treatment(s).

Table 2. Group of experiments with nitrogen rates and placement as main treatments and micronutrient mixes as sub-treatments.

Design	Brief Description	Crop	Number of experiments
1	Treatments: Control, 0, 36, 72, 108, 144, 180 lb N/acre Fertilizer rates: P2O5 seed-row applied at one rate of 27 lb/acre as 0-45-0	Wheat	3
		Barley	11
		Canola	2
		Sub-total	16
2	Treatments: Control, 0, 36, 72 and 108 lb N/acre plus "soil applied mix" at 12 lb/acre Fertilizer rates: P2O5 seed-row applied at one rate of 27 lb/acre as 0-45-0	Wheat	2
		Barley	2
		Sub-total	8
3	Treatments: Urea, Ammonium Nitrate or Calcium Nitrate banded at 54 lb N/acre Fertilizer rates: P2O5 seed-row applied at 27 lb P2O5/acre	Barley	1
		Wheat	1
		TOTAL	26

Soil samples were obtained from every site and were analyzed for routine soil characteristics as well as macro and micronutrient levels (Enviro-Test Laboratories routine methodology). Where different crops were involved on the same site, samples were obtained from the corresponding portion of the field.

Table 3. Group of experiments with phosphorus rates as main treatments and micronutrient mixes as sub-treatments.

Design	Brief Description	Crop	Number of experiments
1	Treatments: Control, 13, 27, and 40 lb P2O5/acre Fertilizer rates: N banded as urea at 72 or 108 lb N/acre	Wheat	5
		Barley	8
		Canola	2
		Sub-total	15
2	Treatments: Control, 9, 18, and 27 lb P2O5/acre Fertilizer rates: N banded as urea at 72 or 108 lb N/acre	Canola	1
		TOTAL	16

Table 4. Group of experiments with methods of soil copper application as main treatments and micronutrient mixes as sub-treatments.

Design	Brief Description	Crop	Number of experiments
1	Treatments: Control, Granular chelated copper band, broadcast or seed-row applied at 2 lb Cu/acre Fertilizer rates: N banded as urea at 72 lb N/acre, P2O5 seed-row applied at 27 lb P2O5/acre and K2O banded at 27 lb K2O /acre	Wheat	4
		Barley	1
		TOTAL	5

All results were subject to analysis of variance utilizing SYSTAT 8.0 and, where appropriate means were separated by the least significant difference (LSD) at $P<0.05$.

Results and Discussion

Application of micronutrient mixes to barley, wheat and canola crops resulted in yield increases in nine of twenty-five, two of nineteen and two of three cases, respectively. Responses varied from 4.6 to 11 bu/acre for barley, 3.2 to 6.1 bu/acre for wheat and 3.9 to 5.5 bu/acre for canola. These responses corresponded to a 4.5 to 10, 4.5 to 12 and 8 to 12 percentage increase in barley, wheat and canola yield. Significant ($P<0.05$) yield increases were obtained with the foliar applications only.

Responses organized on a per site basis are presented in Figures 1 through 5. Yield increases could not be attributed to any particular micronutrient, however, soil test values at the Lethbridge sites might suggest a response to zinc (Zn). Where copper (Cu) deficiency was suspected based

on existing soil testing criteria (Karamanos, 2000), no responses were obtained when only Cu was applied in chelated form.

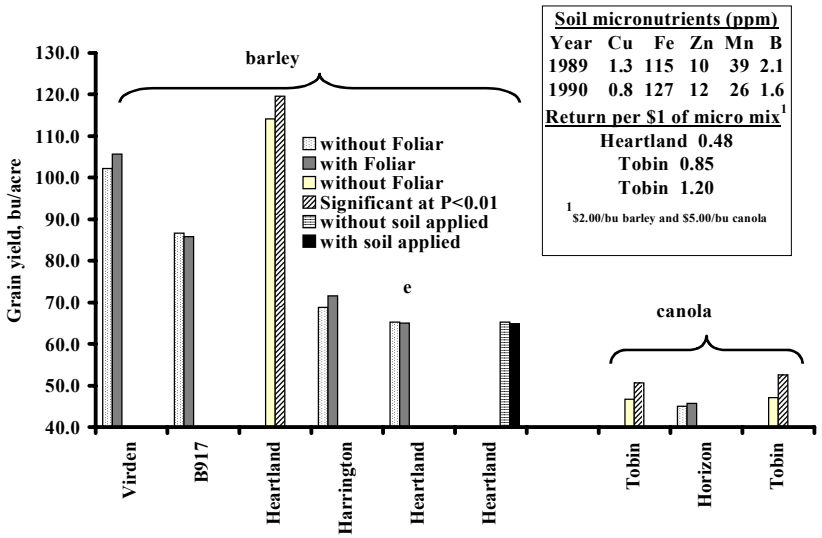

Figure 1. Responses of barley and canola to foliar and soil applied micronutrient mixes at Bentley, Alberta.

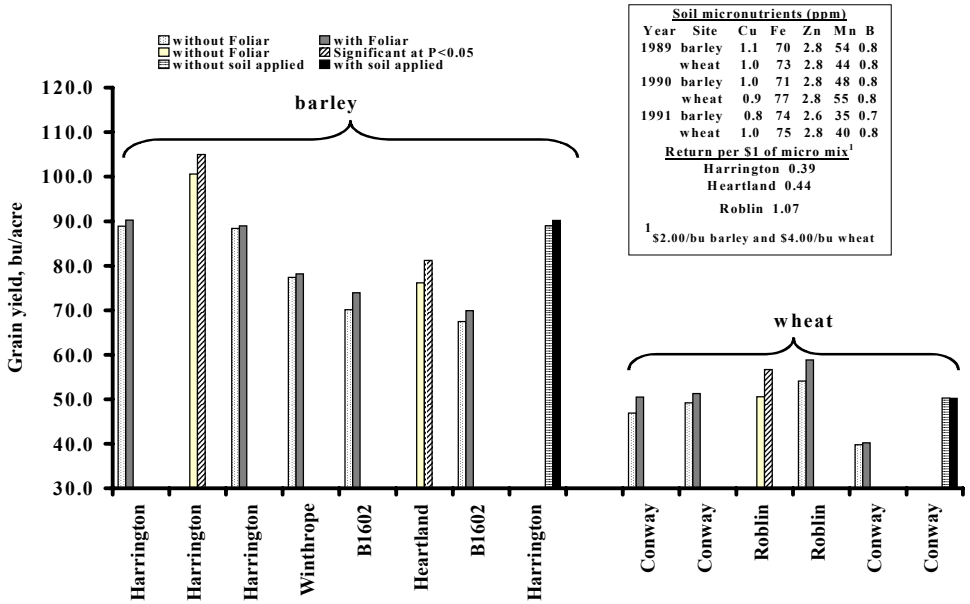

Figure 2. Responses of barley and canola to foliar and soil applied micronutrient mixes at Irricana, Alberta.

"Non-targeted" application of micronutrient mixes at all sites to provide a "balanced" nutrition of crops proved both agronomically inefficient and economically nonviable under western Canadian conditions. Yield increases were both small and unpredictable even when exceptionally high yields were obtained (Figures 1 through 5).

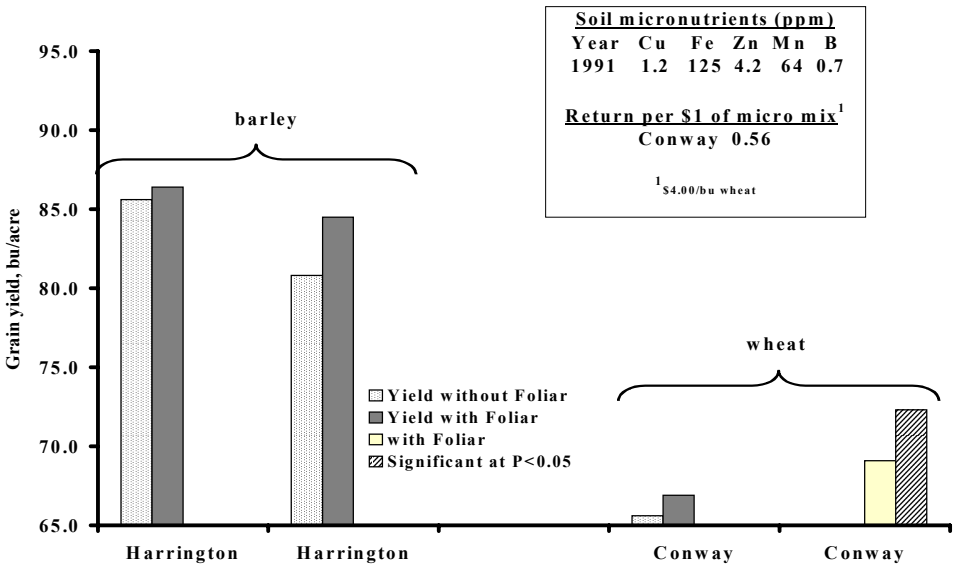

Figure 3. Responses of barley and canola to foliar and soil applied micronutrient mixes at Airdrie, Alberta.

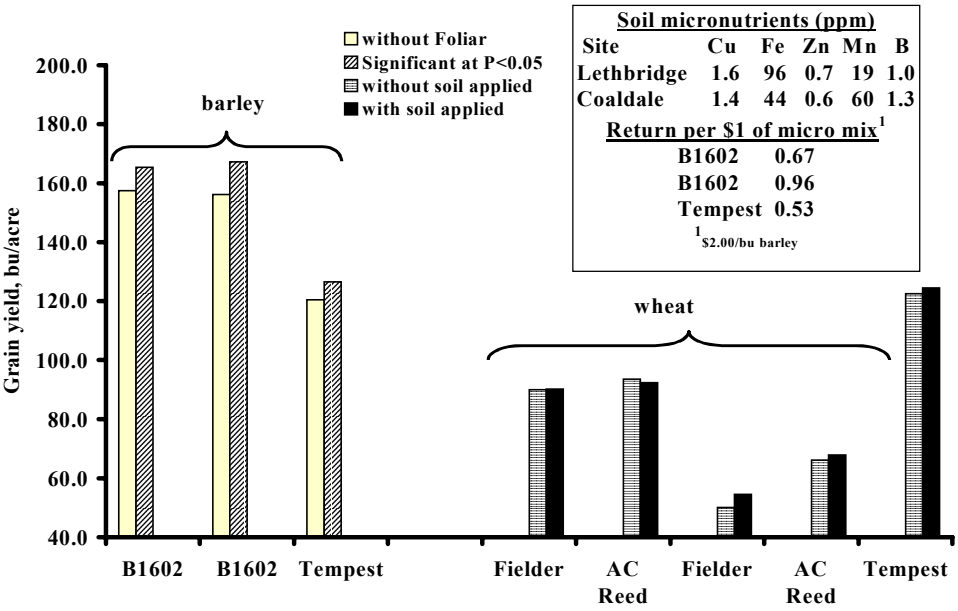

Figure 4. Responses of barley and canola to foliar and soil applied micronutrient mixes in the Lethbridge, Alberta area.

Conclusions

1. Micronutrient mixes do not afford an economical means of correcting micronutrient deficiencies.
2. Western Canadian soils provide crops with a "balanced" nutrition without the aid of a micronutrient mix.

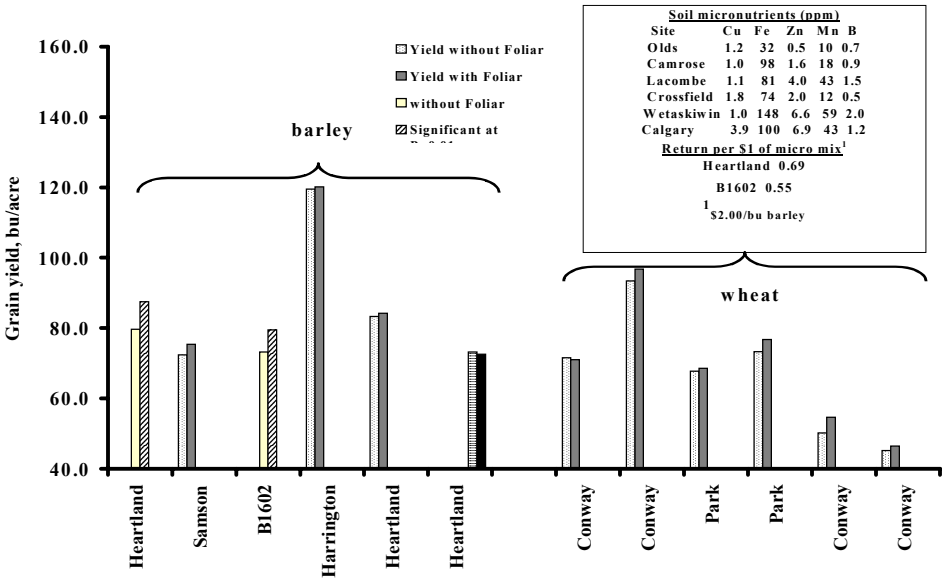

Figure 5. Responses of barley and canola to foliar and soil applied micronutrient mixes in Central Alberta.

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